PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Preparation of Porous Carbon Electrode Using Vegetable Carbon for Use in Air Depolarised Cells

We, COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian Registered body incorporated under the Registration of Societies Act (Act XX1 of 1860), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for the manufacture of porous carbon electrodes and in particular to the manufacture of porous carbon electrodes by the admixture of acetylene black and activated vegetable carbon using polymethylmethacrylate as a binder. Such carbon electrodes may be used in air depolarised cells.

The well-known air depolarised cell is a primary cell which utilizes the oxygen of the air as the cathode component and consists of a porous carbon element as the cathode (through which oxygen circulates and takes part in the reaction), zinc as the anode and sodium hydroxide as the electrolyte. Such an air depolarised cell has an open circuit voltage of 1.40—1.45 volts, operates at 1.10—1.20 volts and has a constant voltage discharge curve for the entire running period at normal discharge rates; it is designed to be assembled in the field.

The air depolarised cell has several applications for instance in railway and marine signalling and switching lamp lighting, telephone and other general instrument operations, and emergency lighting.

An object of the present invention is to provide a process for making a porous carbon electrode element for an air depolarised cell from indigenously available carbon, which forms the bulk of the electrode. By the term "indigenously available carbon" is meant carbon which is available locally and can be manufactured from vegetation.

According to one aspect of the present invention there is provided a process for making a porous carbon electrode element, wherein a mix of activated vegetable carbon, acetylene black and polymethyl methacrylate is pressed in the form of the electrode element.

According to another aspect of the present invention there is provided a porous carbon electrode element particularly for use in air depolarised cells which consists of activated vegetable carbon, acetylene black and polymethyl methacrylate.

Preferably the polymethyl methacrylate is dissolved in a suitable solvent which acts as a binder; such a solvent being benzene or trichloroethylene.

An advantage of a porous carbon electrode element constducted in accordance with the present invention is that most of the element is made from indigenously available vegetable carbon, the only other materials necessary being present in minor amounts. For example, acetylene black may be present in a proportion of about 10% by weight of the element and the polymethyl methacrylate may be present in a proportion of about 3% by weight of the element.

Moreover, the polymethylmethacrylate used in the manufacture of the porous carbon electrode acts also as a water proofing agent. This results in reducing the number of steps involved in the manufacture of carbon electrode

elements from four, viz. those of blending, pressing, baking and water-proofing, as performed in the usual method of making porous carbon electrode elements, to two, merely those of blending and pressing.

The fact that the porous carbon electrode element consists of a blend of vegetable carbon, acetylene black and polymethyl methacrylate and can be made by a simple procedure, as described hereinafter, involving no costly equipment (a mixer and a hydraulic press being all that is required) makes production economical.

In order that the invention may be more clearly understood and readily carried into effect, the procedure for making a porous carbon electrode element, in particular an electrode element for a railway type air depolarised cell of capacity 500 ampere hours (details of the railway type air depolarised cell appear in B.S. 1335: 1946) will now be described with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a cell using a carbon electrode element made in accordance with the present invention;

FIGURE 2 is a cross section (on an enlarged scale) on the line II—II of Figure 1;

FIGURE 3 is a cross section on the line III—III of Figure 2;

FIGURE 4 is an exploded perspective view of a mould for making the carbon electrode element of the cell shown in Figures 1 to 3; and

FIGURE 5 is a side elevation of the mould shown in Figure 4 with the cover spaced from the remainder of the mould.

Referring to Figures 1 to 3, the cell comprises a casing 11 having a cover plate 12 from which is suspended a porous carbon electrode element or cathode 13. Surrounding the cathode is a zinc anode 14 which is also suspended from the cover plate 12.

The anode 14 is fully immersed in electrolyte 15 whilst the cathode 13 is only partially immersed in the electrolyte. The electrolyte is sodium hydroxide and as is shown in the drawing with the electrodes in poistion, the cell is approximately 90% full of electrolyte. The anode 14 is suspended from the cover plate 12 by means of two support members 16 which are secured to respective rods 17 which pass through the cover plate 12 and carry lock nuts 18 which act as terminals. The cathode 13 is supported on a rod 21 which passes through its centre, is formed at its lower end with a head 22 and at its upper end carries lock nuts 23 which act as a terminal. The rods 17 and 21 are nickel-plated mild steel. The cathode 13 is sandwiched between two discs 24 and 25, the lower disc 24 engaging the head 22 and acting to support the weight of the cathode 13 and the upper disc 25 abutting a further lock nut 26 and acting to compress the cathode between it and the lower disc 24.

Referring now to Figures 4 and 5, there is shown a mould for the manufacture of the porous electrode 13 shown in Figures 2 and 3. The mould comprises first and second wooden mould halves 41 and 42 which define a chamber 43 in which the carbon material is moulded. Sandwiching the mould halves 41 and 42 are two clamping plates 44 and 45 which are clamped towards each other by means of bolts 46 and wing nuts 47. The bolts 46 pass through the mould halves and each clamping plate is provided with a handle 48 which can be gripped so as to assist in separation of the clamping plates after a moulding operation. Two brass inserts 49 are formed in the mould halves and are used for the reception of a cover or top plate for the mould as will be hereinafter explained.

The base of the mould is formed by a base plate 51 which has at its centre a locating plinth 52 which is dimensioned so as to closely fit within the chamber 43 to extend a small distance upwardly within the chamber. The plinth 52 carries a shaping disc 53 which is used to form a recess in an electrode element formed in the mould.

A top plate 54 has a downwardly extending plunger 55 of a shape such as to fit within the chamber 43 and compress material within the chamber. Two adjustment screws 56 are carried in the top plate and engage with the brass inserts 49 to permit the top plate to be forced to a given position relative to the remainder of the mould and so compress material therewithin to a given volume. The plunger 55 and top plate 54 are formed with a vent 57 for the escape of gases during compression of material within the mould. The vent also acts as a guide for the drilling of a bore to receive the rod 21.

The manufacture of a porous carbon electrode element in accordance with the invention is as follows:—

There is first prepared a blend consisting of activated vegetable carbon, such as activated coconut shell charcoal in powdered form (preferably between −100 mesh and +140 mesh —British Standard Sieve Series) and from 5 to 15% by weight of acetylene black (preferably 10% by weight) to which has been added polymethyl methacrylate (from 1.5 to 3.0% by weight but preferably 3%) dissolved in a suitable solvent such as benzene or trichlorethylene. If the polymethyl methacrylate were added only in an amount of up to 1.5% by weight, the mechanical strength of the completed electrode element would be adversely affected whereas if more than 3.0% by weight were added, the resistance of the electrode would tend to increase.

Thus 720 grams of activated coconut shell charcoal and 80 grams of acetylene black are intimately mixed using a blender or mixing

machine with the addition of 25 grams of polymethyl methacrylate dissolved in 500 cc. of benzene or trichloroethylene.

The blend is then pressed in the mould at a pressure of between one quarter and one half tons per square inch. After pressing, the electrode element 13 is allowed to weather-dry in the atmosphere before removal from the mould.

For electrical contact the central nickel-plated mild steel rod 16 is passed through the cathode 13 with a nickel-plated mild steel disc 25 on top and a larger nickel-plated mild steel disc 24 at the bottom.

A seamless plastic or rubber ring which is two inches wide and 1/16 inch thick is then inserted around the top portion of the electrode and wax coating given to the lower end of the ring to avoid seepage of the electrolyte to the top surface of the electrode.

The cathode is then assembled in a cell which gives an open circuit voltage of between 1.40 and 1.45 volts and a short circuit current of about 6 amperes. It also meets the following typical set of requirements:—

0.06 amperes for 30 minute periods, 30 times a day;

3.0 amperes for 15 second periods, 30 times a day;

0.17 amperes continuous discharge until the 500 ampere hours designed capacity is realized.

Experiments on the evaluation of active carbons without any admixture of acetylene black have shown that out of various varieties of active carbon, the electrode elements made from coconut shell charcoal when incorporated in the railway type air depolarised cell, gives the highest short circuit current and offers the lowest resistance. For example, a value of the short circuit current of 1.8 amperes, and a resistance of a block of coconut shell charcoal with 3% polymethyl methacrylate as binder (3×2.6 cm. diameter size) of 12 ohms, are obtained for coconut shell charcoal as compared to the values of short circuit current ranging from a few milliamperes to a maximum of 800 milliamperes and resistances (under identical conditions) ranging from 57 ohms to 125 kilo-ohms for the other varieties of active carbon.

Thus the coconut shell charcoal (without any admixture of acetylene black) though the best of the indigenously available active carbons, when assembled in the form of railway type cell fulfils the two requirements namely intermittent discharge at 0.06 ampere for 30 minute periods, 30 times a day, and continuous discharge at 0.17 ampere until 500 ampere hours are obtained, does not meet another requirement namely 3.0 amperes for 15 second periods, 30 times a day.

The examples describes in detail the method of making a porous carbon electrode element, in particular, that of the special railway type air depolarised cell of 500 ampere-hours capacity. However, the invention may be utilised in the manufacture of porous carbon electrode elements for other types of air depolarised cells, or for any other use.

WHAT WE CLAIM IS:—

1. A process for making a porous carbon electrode element wherein a mixture of activated segetable carbon, acetylene black and poly methyl methacrylate is pressed into the form of the electrode element.

2. A process as claimed in claim 1 wherein the activated vegetable carbon is activated coconut shell charcoal.

3. A process as claimed in either of the preceding claims wherein the acetylene black is added to the activated vegetable carbon to the extent of 5—15% by weight.

4. A process as claimed in any one of the preceding claims wherein the poly methyl methacrylate is added to the mixture of activated vegetable carbon and acetylene black to the extent of 1.5—3.0% by weight.

5. A process as claimed in any one of the preceding claims wherein the poly methyl methacrylate is added as a solution in benzene or trichloretylene.

6. A process as claimed in any of the preceding claims wherein the activated vegetable carbon is added in powdered form preferably between −100 and +140 mesh size (British Standard Sieve Series).

7. A process as claimed in claim 1 for making a porous carbon electrode element substantially as herein before described with reference to the foregoing example.

8. A porous carbon electrode elements particularly for use in Air Depolarised cells which consists of activated vegetable carbon, acetylene black and poly methyl methacrylate.

9. A porous carbon electrode element as claimed in claim 8 wherein the activated vegetable carbon is activated coconut shell charcoal.

10. A porous carbon electrode element as claimed in claims 8 and 9 wherein acetylene black is present in an amount of between 5 and 15% by weight.

11. A porous carbon electrode element as claimed in any one of claims 8—10 wherein the poly methyl methacrylate is present in an amount of between 1.5—3% by weight.

12. A porous carbon electrode element as claimed in any one of claims 8—11 wherein the activated vegetable carbon is initially in powdered form, preferably between −100 and +140 mesh size. (British Standard Sieve Series).

13. A porous carbon eltctrode element as claimed in claim 8 substantially as hereinbefore described with reference to the foregoing example.

14. A porous carbon electrode element

when made by the process as claimed in any one of claims 1—7.

15. An Air Depolarised cell containing a porous carbon electrode element as claimed in any one of claims 8—14 wherein the porous carbon electrode element forms the cathode and utilises oxygen of the air and the anode is zinc and the electrolyte is sodium hydroxide.

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Fig. 2.

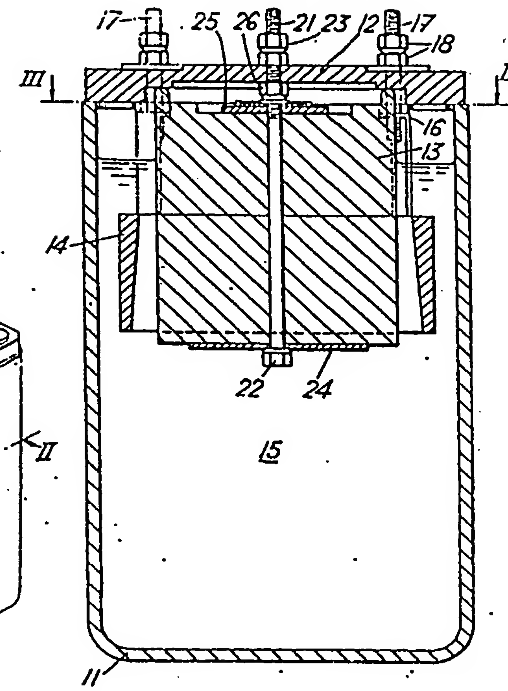


Fig. 1.

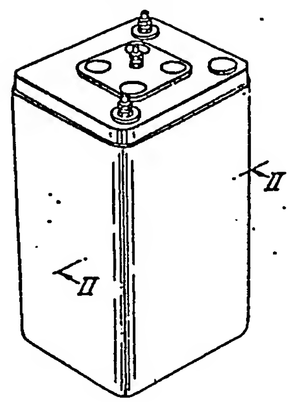
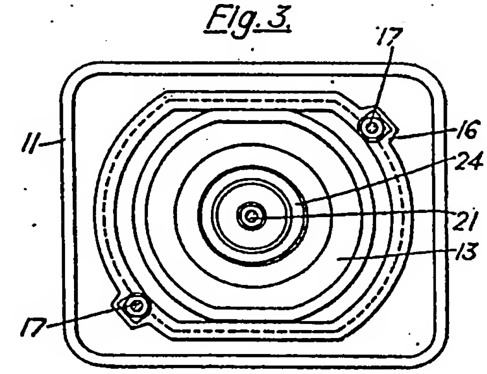


Fig. 3.



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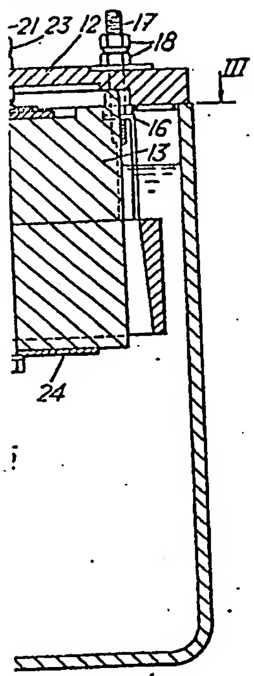


Fig. 4.

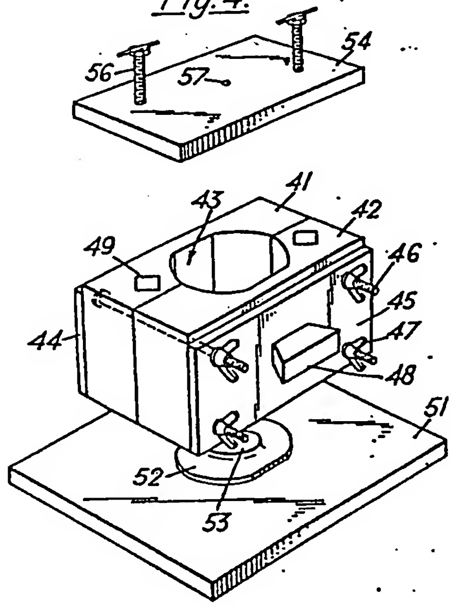
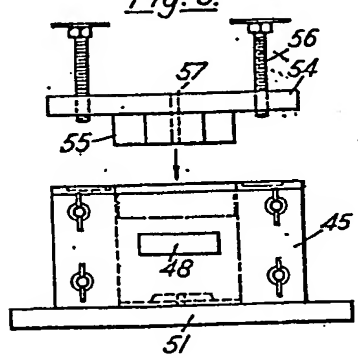
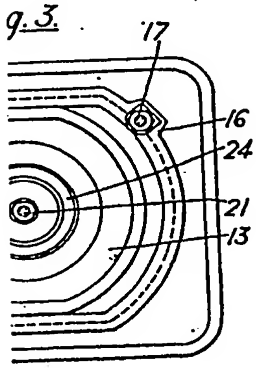


Fig. 5.



g. 3.



1094914 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

Fig.1.

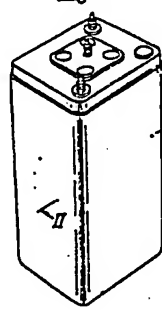


Fig.2.

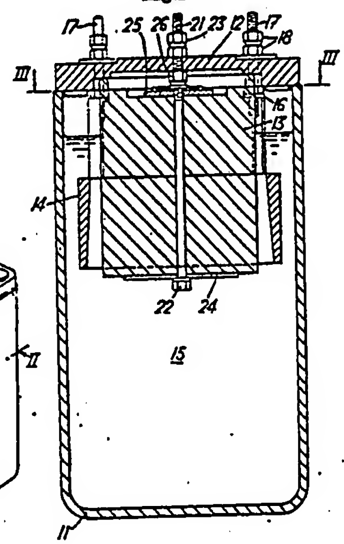


Fig.3.

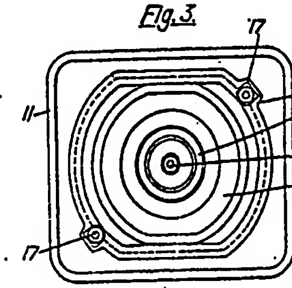


Fig.4.

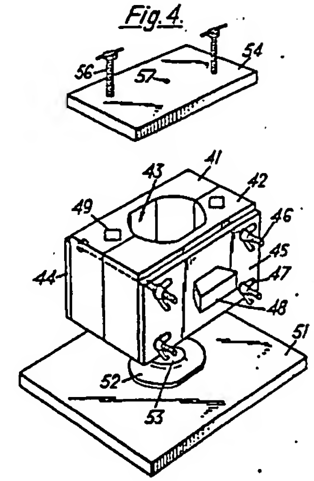


Fig.5.